

**National Exposure Research Laboratory  
Research Abstract**

Government Performance Results Act (GPRA) Goal #1–Clean Air  
Annual Performance Measure #214

Significant Research Findings:

**The Contribution of Outdoor Fine Particle Concentrations to the Exposure of High-Risk Sub-populations****Scientific  
Problem and  
Policy Issues**

Significant associations have been found in many areas between fine particulate matter (PM) concentrations measured at ambient monitoring sites and increased mortality and morbidity. The persons most at risk include those with respiratory or cardiovascular problems. The National Academy of Sciences (NAS) placed studying the relationship between the ambient PM concentrations measured at a central outdoor site and the personal exposures of these at-risk persons as the first goal in their 13-year research portfolio for EPA PM research. (Cf.. *Research Priorities for Airborne Particulate Matter: IV. Continuing Research Progress*, National Academies Press (2004)) One difficulty determining this relationship is in differentiating between particles from outdoor- and indoor-generated sources.

**Research  
Approach**

One approach for differentiating between particles from outdoor- and indoor-generated sources is to identify and use a marker which is present in outdoor-generated particles but not indoor-generated particles. Several studies have found that sulfur might be a suitable marker. The EPA's National Exposure Research Laboratory collected personal, indoor, and outdoor samples in an exposure study conducted in the Research Triangle Park area of North Carolina. In this study, 29 adults with hypertension and 8 adults with implanted defibrillators were monitored for 7 days each season, for up to four seasons. About 800 sets of personal, indoor, and outdoor filters were analyzed for sulfur content. The hypothesis that sulfur is not generated indoors was tested by graphically comparing indoor and outdoor concentrations.

**Results and  
Impact**

The sulfur marker method for estimating exposure to outdoor fine PM was successfully demonstrated in this study. The hypothesis that sulfur is not generated indoors was confirmed for all but one participant, who used tap water containing sulfide in his room humidifier. The portion of fine particle exposure due to outside ambient PM ranged between 33% and 77% using the sulfur marker method. On average, indoor sources contributed more than half of the personal PM exposure.

**Research  
Collaboration and  
Research  
Products**

The research summarized here is contained in an upcoming EPA research report (APM 214):

Wallace, L., Williams, R., Suggs, J. Use of Indoor-Outdoor Sulfur Concentrations to Estimate the Infiltration Factor, Outdoor Exposure Factor, Penetration Coefficient, and Deposition Rate for Individual Homes (APM-214). US EPA, National Exposure Research Laboratory, Research

Triangle Park, NC. EPA/600/R-xx/xxx. 2004.

A journal article has also been submitted for publication:

Wallace, L. and Williams, R. Use of Indoor-Outdoor Sulfur Concentrations to Estimate the Infiltration Factor, Outdoor Exposure Factor, Penetration Coefficient, and Deposition Rate for Individual Homes. *Environmental Science & Technology*. American Chemical Society, Washington, DC, 39(6):1707-1714, (2005).

The two earlier EPA project reports (APM-1 and APM-21) are:

Wallace, L., Williams, R., Suggs, J. et al., Exposure of High-Risk Subpopulations to Particles: Final Report—APM-21. US EPA, National Exposure Research Laboratory, Research Triangle Park, NC. EPA/600/R-03/145. February, 2004.

Williams, R. et al., Preliminary Particulate Matter Mass Concentrations Associated with Longitudinal Panel Studies: Assessing Human Exposures of High Risk Subpopulations to Particulate Matter. US EPA, National Exposure Research Laboratory, Research Triangle Park, NC. EPA/600/R-01/086.

The main publications dealing with the Research Triangle Park study are:

Williams RW, Suggs, J, Rea A, Leovic K, Vette A, Croghan C, Sheldon L, Rodes C, Thornburg J, Ejire A *et al.* (2003a). The Research Triangle Park particulate matter panel study: PM mass concentration relationships, *Atmospheric Environment* **37**(38):5349-5363

Williams, RW, Suggs J, Rea A, Sheldon L, Rodes C, Thornburg J (2003b). The Research Triangle Park particulate matter panel study: modeling ambient source contribution to personal and residential PM mass concentrations, *Atmospheric Environment* **37**(38):5365-5378.

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#### Future Research

Future studies of the sulfur marker method for estimating personal exposure to outdoor fine PM should investigate the validity of this method for particles such as iron and crustal elements which are at the upper end of the fine fraction. Such particles potentially have different penetration and deposition behavior than the sulfur tracer. A 3-year particle exposure study in the Detroit was begun during the summer of 2004. The study, which includes measurements of personal, indoor, and outdoor exposure to particles, gases, and elements, will provide opportunities for further investigating the sulfur marker method.

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